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METHODS AND SYSTEMS FOR PROVIDING TRANSPORT OF MEDIA GATEWAY CONTROL COMMANDS USING HIGH-LEVEL DATALINK CONTROL (HDLC) PROTOCOL

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Description

METHODS AND SYSTEMS FOR PROVIDING TRANSPORT OF MEDIA GATEWAY CONTROL COMMANDS USING HIGH-LEVEL DATALINK CONTROL (HDLC) PROTOCOL

Technical Field

The present invention relates to methods and systems for transporting media gateway control commands over high-level data link control (HDLC). More particularly, the present invention relates to methods and systems for remote management of a media gateway using media gateway control (MEGACO/H.248) commands embedded in HDLC frames transported over time-division multiplex (TDM) links.

Background Art

Telecommunication networks originated over a century ago and continue to evolve, driving the development of new standards, protocols, and topologies to provide new and optimize existing telephony services. The SS7 (Signaling System 7) protocol and other signaling protocols have been developed to provide digital out-of-band signaling for both the landline and wireless telephone networks. The modern public switched telephone network (PSTN) uses signaling messages to establish telephone call connections and provide

advanced services. These signaling messages are transported over signaling links, which are typically TDM communications channels. The TDM communications channels used for PSTN call signaling are usually separate from other networks, such as data networks, for enhanced reliability and security.

Data networks, such as the Internet and private data networks, have been developed in parallel with the evolving PSTN. While the function of the PSTN is primarily to provide end-to-end voice connections between telephone service subscribers, data networks were developed to communicate data between the interconnected computers. Because data communications over the Internet are less delay sensitive and less critical to national security, the protocols developed for the Internet do not have the inherent reliability as those developed for PSTN.

Over time, the functions provided by the PSTN have become increasingly more sophisticated and the line between data networks and PSTN has blurred. For example, data protocols are being used with increasing frequency to transport signaling and network management information between elements of the PSTN and enable PSTN users to receive advanced services.

Figure 1 is a block diagram of a portion of the PSTN network **100**. In the PSTN network, a host **102** provides basic control functions, such as call processing and maintenance, for downstream equipment. For example, downstream from the host **102** is a remote switching unit (RSU) **104** and a remote line unit (RLU) **106**. The RSU **104** may provide switching for

downstream RLUs **106** or may provide local loop service to individual subscribers (not shown). Likewise, RLUs **106** may provide local loop service to subscribers (not shown) and local switching between the RLUs subscribers to complete local calls. Calls made to locations not served by the RLU **106** are forwarded upstream to the RSU **104**.

In some instances, it may be desirable to replace legacy PSTN network elements, such as remote switching systems with new network elements, such as IP-capable media gateways to provide enhanced services to subscribers located in remote areas. However, in areas where separate data and PSTN communications facilities have not evolved, the management of sophisticated network elements, such as media gateways, cannot easily be accomplished using signaling protocols standardized for media gateways. For example, media gateway control protocols, such as MCGP and MEGACO are typically transmitted to media gateways over data networks using UDP/IP. Conventional telecommunications signaling links interconnecting central offices with remote switching equipment used proprietary transport protocols unsuitable for carrying media gateway control commands.

One possible solution for a telecommunications service provider who desires to replace existing legacy equipment with IP-based media gateways is to construct an IP network separate from the existing telecommunications signaling network and connect the media gateway controllers to the remote media gateways via the IP network. However, constructing a separate IP network requires the deployment of multiple Ethernet switches and IP routers,

which increases the cost of providing supplementary services to subscribers located in remote areas.

Accordingly, there is a need to provide a mechanism to permit management and control of remote network equipment using available TDM links and standard protocols.

Summary of the Invention

According to one aspect, the present invention includes a method for transmitting a media gateway control command from a media gateway controller to a remote media gateway. As used herein, the term "media gateway control command" refers to any command that may be originated or forwarded by a media gateway controller to a remote media gateway. Examples of media gateway control commands include call control commands, network management messages, and media gateway maintenance commands.

In one exemplary implementation, the media gateway controller is in communication with a local media gateway, and the local media gateway has an interface to a TDM link to the remote media gateway. The media gateway control command is sent from the media gateway controller to the local media gateway. The local media gateway inserts the media gateway control command into a command packet, inserts the command packet into an HDLC frame and transmits the frame to the remote media gateway over the TDM link. The remote media gateway receives the HDLC frame, removes the command packet and removes the media gateway control command from the command packet.

In accordance with another aspect, the invention includes a media gateway having a plurality of network interfaces for sending and receiving media streams to and from external networks and a plurality of voice processing resources operatively associated with the network interfaces for processing the media streams received from the external networks. The media gateway also includes a command interface for receiving commands from a media gateway controller and a controller operatively associated with the network interfaces and the voice processing resources for controlling the network interfaces and the voice processing resources. The controller is operatively associated with the command interface and is capable of differentiating between commands intended for the media gateway and commands intended for a remote media gateway. An HDLC interface is operatively associated with the controller and is capable of sending and receiving HDLC frames. The HDLC frames may contain a media gateway control command or a response to a media gateway control command. The commands and responses are encapsulated in a command packet and transported in the information portion of the HDLC frame. The media gateway includes a TDM interface for sending the HDLC frames to a remote media gateway via a TDM link.

Another aspect of the invention includes a system for managing a remote media gateway. The system includes a media gateway controller and a local media gateway. The media gateway controller generates media gateway control commands. The local media gateway is operatively associated with the media gateway controller and is capable of differentiating between media

gateway control commands received from the media gateway controller that are intended for the local media gateway and those not intended for the media gateway. The local media gateway has an HDLC interface and means for encapsulating media gateway control commands not intended for the local media gateway into HDLC frames for transmission by the HDLC interface. The local media gateway also has a TDM interface for communicating the HDLC frames to the remote media gateway.

Accordingly, it is an object of the present invention to provide methods and systems for sending media gateway control commands to a remote media gateway.

It is another object of the invention to provide methods and systems for controlling a media gateway using the existing telecommunications network infrastructure.

Some of the objects of the invention having been stated hereinabove, other objects will become evident as the description proceeds when taken in connection with the accompanying drawings as best described hereinbelow.

Brief Description of the Drawings

Preferred embodiments of the invention will now be explained with reference to the accompanying drawings of which:

Figure 1 is a block diagram of a traditional PSTN network;

Figure 2 is a block diagram of a communications network in which the present invention may be implemented;

Figure 3 is a block diagram of a conventional HDLC frame;

Figure 4 is a block diagram of a management command packet in accordance with the invention;

Figure 5 is a block diagram of a media gateway and a media gateway controller that may be used to implement an embodiment of the invention;

Figure 6 is a block diagram of a portion of an exemplary control module of a media gateway that may be used to implement an embodiment of the invention;

Figure 7 is a flow diagram of an exemplary method for forwarding commands from a local media gateway to a remote media gateway in accordance with the invention; and

Figure 8 is a flow diagram of an exemplary method for receiving, in a remote media gateway, media gateway control command encapsulated in an HDLC frame transmitted from commands from a local media gateway in accordance with the invention.

Detailed Description of the Invention

Figure 2 is a block diagram of a communications network **200** in which the present invention may be implemented. A media gateway controller **202** communicates with a local media gateway **204** through an Ethernet port (not shown). The media controller **202** may be connected directly to the local media gateway **204** or the media gateway controller **202** may be connected to the local media gateway **204** through an Ethernet switch **206**. Using the Ethernet switch **206** allows the media gateway controller **202** to manage more than one

local media gateway **204** or permits more than one media gateway controller **202** to manage the local media gateways **204**. If more than one media gateway controller **202** is present, one media gateway controller **202** may be designated as an active media gateway controller **202** and the other as a backup controller in the event that the active controller fails.

Each media gateway **204** includes a time division multiplex (TDM) interface for connection to a TDM network **208**. TDM network **208** may be the same TDM network that was previously used to carry voice and data between a central office and a remote end office. The TDM network uses time slots to provide digitized voice and data connectivity. Other media gateways **210**, remote to the local media gateways **204**, are similarly connected to the TDM network **208**. Thus, the TDM network **208** provides connectivity between local media gateways **204** and remote media gateways **210**. By designating certain time slots as management channels, the TDM network **208** can be used to provide a pathway through which commands from the media gateway controller **202** can be sent to the remote media gateways **210** and any other network supported equipment, such as emergency standalone (ESA) processor **212**,thus eliminating the need to provide a media gateway controller local to the remote media gateways **210**. In addition, because existing TDM links may be used to carry the media gateway control signaling, the need for constructing a new data network between MGCs **202** and remote MGs **210** is reduced. Nevertheless, it may be desirable to use both a data network and a TDM network to carry media gateway control signaling between MGCs **202** and

remote MGs **210** to provide, for example, a primary and a secondary signaling pathway.

In accordance with one aspect of the invention, a media gateway control command is embedded within an HDLC frame and transmitted to a remote media gateway using one or more time slots in a TDM link. Figure 3 is a block diagram of a conventional HDLC frame **300**. The HDLC protocol is synchronous and relies on the physical layer for clocking and synchronization of the transmitter/receiver. An HDLC frame starts and ends with a flag sequence field **302** that contains the delimiter flag 0x7E. All data stations that are attached to the data link continuously hunt for this sequence to distinguish the beginning and ending of frames. The HDLC protocol uses a zero insertion/deletion process (bit-stuffing) to ensure that a data bit pattern matching the delimiter flag does not occur in another field.

Following the flag sequence field **302** is an address field **304**. The contents of the address field depend on whether the HDLC frame contains a command or response. In command frames, the address field **304** identifies the data station for which the command is intended. In response frames, the address field **304** identifies the data station from which the response originated. The address field **304** is typically either 8 or 16 bits wide. When carrying media gateway control commands to a remote media gateway, the address field **304** may be set to the MAC address of the remote media gateway.

Following the address field **304** is an 8-bit control field **306**. The control field **306** indicates the class of commands or responses to be carried out by the

frame and contains sequence numbers that specify any sequence that the command must follow. The control field **306** indicates the type of command that is contained in an information field **308** that follows the control field **306**. When the information field **308** carries a media gateway control command, the control field **306** may be set to a predetermined value that the media gateway uses to identify that a media gateway control command is present.

The data or information field **308** may include any user-specified bits, other than the delimiter flag. In most cases, the information field **308** is formatted in an N-by-8-bit structure (e.g., ASCII text). However, each element in the information field **308** may be an unspecified number of bits. If the number of bits in the information field **308** is not a multiple of eight, padding bits may be added to the data in the information field **308** to achieve an octet alignment. As will be described in detail below, in accordance with the present invention, the information field **308** may carry media gateway control commands.

Following the information field **308** is the frame check sequence field **310**. Any cyclic redundancy check (CRC) type frame checking sequence may be used, although 16-bit and 32-bit sequences are the most common. The CRC in the frame check sequence field **310** is used to determine whether the HDLC packet was received without errors. A second flag sequence field **302** follows the frame check sequence field **310** and terminates the HDLC packet **300**.

In accordance with the invention, media gateway management or control commands may be embedded in the information field **308** of the HDLC frame **300**. Figure 4 is a block diagram of a management command packet **400** in accordance with the invention. The management command packet **400** includes a packet header **402** and a packet payload **404**. In one embodiment, the packet header **402** contains four 8-bit fields. The first field is a version identification field **406** that indicates the version of the command packet **400**. Changes to the content or placement of the fields in the packet may be desirable to accommodate different applications or different versions of the same application. These changes may be indicated to the receiving application by a change in the version identification field **406**.

The second field in the packet header **402** is a command flag **408** that indicates the type of payload contained in the command packet **400**. For example, in one embodiment, 0x00 indicates the payload is an IP packet and a 0x05 indicates that the payload is a media gateway management command. Other data values may be defined to identify other types of payloads.

The third field in the packet header **402** is a command identification field **410**. The command identification field **410** identifies the destination interface for IP packets to be sent to a remote media gateway and indicates the command ID for media gateway management commands sent to the remote media gateway. For example, if the payload of the command packet includes an IP packet, such as a network management packet or a call control packet, the command identification field **410** may be set to 0x01. If the payload

contains a media gateway maintenance packet, the command identification field **410** may be set to 0x00. These values in the command identification field **410** indicate to the receiving media gateway as to whether the command packet should be sent to the management interface or the call control interface. If the payload stores a media gateway management command, command identification field **410** stores a value indicating the command ID.

It should be noted that the composition and arrangement of the packet header is intended to be exemplary and is not intended to limit the invention. The placement of the fields in the packet header **402** can be changed, or fields can be eliminated without altering the function of the packet header. For example, the version ID field **406** and the reserved field **412** can be eliminated from the packet to produce a more compact packet header. These and other modifications to the packet header are intended to fall within the scope of the invention.

As noted above, the content of the packet payload **404** is identified by the command flag **408**. For example, the command flag **408** may be set to a predetermined value to indicate that the packet payload **404** is a command packet when the packet payload **404** contains maintenance and control commands to test or configure the destination media gateway. Examples of functions initiated by the command packet may include performing a test of the HDLC interface, setting up HDLC channels, or performing an upgrade of the media gateway software. The command flag **408** may be set to a different

value when the packet payload **404** contains a media gateway call control or network management message.

The processing of command packets may be better understood through a brief description of an exemplary implementation in a media gateway. Figure 5 is a block diagram of a media gateway **501** that may be used to implement an embodiment of the invention. The media gateway **501** includes a control module **503** that functions as the command interface for a media gateway controller **505**. Commands from the media gateway controller **505** are received and processed by the control module **503**. The control module **503** may, in turn, provide instructions to or acquire information from other modules within the media gateway **501** in order to comply with the commands from the media gateway controller **505**.

The media gateway **501** may also include interfaces for sending and receiving media streams to and from a plurality of different types of networks. For example, the media gateway **501** may also include time division multiplexed (TDM) network interface cards **507**. TDM network interface cards **507** send and receive media streams from external TDM networks. TDM network interface cards **507** may implement any suitable physical layer protocol for sending and receiving media streams over TDM links. For example, each TDM NIC **507** may terminate one or more TDM voice trunks.

In addition to TDM network interface cards, the media gateway **501** may include packet network interface cards **509**. Each packet network interface card **509** may implement network layer functions, such as packet forwarding

functions, including Internet protocol (IP) forwarding functions. In the illustrated example, different packet network interface cards are provided to connect to external Ethernet, Packet Over SONET (POS), and asynchronous transfer mode (ATM) networks.

In Figure 5, the media gateway **501** includes voice server modules **511**, which may include circuitry for implementing one or more voice over packet protocols, such as Real-time Transmission Protocol (RTP). In order to switch packets from network interface cards **509** to the appropriate voice server module **511**, the media gateway **501** includes a packet matrix module **513**. The packet matrix module **513** switches packets under the control of the control module **503**. In addition to packet matrix module **513**, media gateway **501** includes a TDM matrix module **515** for switching data in TDM time slots between TDM NICs **507** and voice server modules **511**. TDM matrix modules **515** are also controlled by control module **503**.

As noted above, the control module **503** functions as the command interface for the media gateway **501**. The functions performed by the control module **503** may be divided between one or more processing units. Figure 6 is a block diagram of a portion of the control module **503**. In Figure 6, the control module **503** includes a main control module **602** and a TDM control module **604**. Control module **503** may include other modules to perform other functions of the media gateway without departing from the scope of the invention.

In a multiprocessor system, it is desirable to have some mechanism available to permit the various processors to communicate with each other.

Accordingly, main control module **602** and TDM control module **604** each include interprocessor communications (IPC) circuitry **606**. In the exemplary embodiment, the IPC **606** includes circuitry for sending and receiving Ethernet frames. Frames received by the IPC **606** are checked for errors and then forwarded to an I/O handling device (IOHD) **608**. In the main control module **602**, the IOHD **608** includes two interfaces. One interface is a call control interface **610**. The other interface is a management interface **612**. Each interface may be assigned a different IP address. Both the call control interface **610** and the management interface **612** communicate with a main control module application **614** by forwarding packets through an IP stack **616**. After receiving the packets, the main control module application **614** may perform a function requested by control commands in the packets or may initiate commands to another control module. Information and commands from the main control module application **614** are forwarded through the IP stack **616** to the appropriate interface, that is, either the call control interface **610** or the management interface **612**. The IOHD **608** forwards these packets through the IPC **606** to the appropriate processor module.

As shown in Figure 6, the main control module **602** may communicate with the TDM control module **604**. The TDM control module **604** includes an IPC **606** and IOHD **608**. The TDM control module **604** also includes an associated TDM control module application **618** for executing various maintenance and configuration functions. The main function of the TDM control module **604** is to provide an HDLC interface to the media gateway.

In accordance with the invention, media gateway control commands are transmitted from a media gateway controller to a remote media gateway using TDM channels. In Figure 6, TDM NICs **507** provide interfaces to external TDM channels so that HDLC driver **620** on the TDM control module **604** can send call control and management commands to a remote media gateway. The external TDM links to the remote media gateway may be existing TDM links used to carry call signaling and bearer channel data between PSTN switching offices. Because existing TDM channels can be used to carry HDLC-encapsulated media gateway control commands according to the present invention, the need for constructing a stand-alone IP network for such communication is reduced.

Moreover, in Figure 6, TDM NICs **507** may provide redundant access to the external TDM links. As a result, if an HDLC channel on one external TDM link fails, connectivity with the remote media gateway is not lost because traffic can be dynamically switched to a new HDLC channel on a TDM channel accessible via an alternate TDM NIC **507**. For example, HDLC driver **620** may detect faulty HDLC links and dynamically switch traffic to an alternate link. Thus, by using redundant TDM links and redundant TDM network interfaces provided by a media gateway, the present invention provides reliable communications with a remote media gateway.

The present invention is not limited to using the TDM interfaces provided by a media gateway to send media gateway management, network management, and call control commands from a media gateway controller to a

remote media gateway. In an alternate implementation, a media gateway controller may directly terminate one or more TDM links and contain the same functionality described with respect to Figure 6 for sending and receiving HDLC frames to and from a remote media gateway controller via the TDM links. Using a media gateway or a media gateway controller to access TDM links and send call control commands, network management commands, and media gateway maintenance commands via TDM channels is intended to be within the scope of the invention.

When processing a received HDLC frame, the HDLC driver **620** verifies the integrity of the HDLC frame **300**, described above with reference to Figure 3, and removes the information field **308** from the HDLC frame **300**. As described above with reference to Figure 4 and in accordance with the invention, the information field **308** contains a management command packet **400**. The HDLC driver **620** forwards the command packet **400** to the IOHD **608** for further processing. The IOHD **608** on the TDM control module **604** forwards the command packet **400** to the IOHD **608** on the main control module **602** using the IPC **606**. The IOHD **608** on the main control module **602** examines the contents of the command packet **400**.

As described above with respect to Figure 4, the management command packet **400** includes a packet header **402** and a packet payload **404**. The IOHD **608** examines the packet header **402** to determine the destination of and type of packet in the packet payload **404**. This may be accomplished by examining the command flag **408** of the command packet **400**. If the packet

payload contains an IP packet, the IOHD **608** examines the command identification field **410** to determine the destination interface ID. Based on the destination interface ID, the packet payload is forwarded to the main control module application **614** using either the management interface **612** or the call control interface **610**.

Accordingly, a media gateway controller can manage a remote media gateway by sending media gateway control commands through a local media gateway, over existing TDM links, to the remote media gateway. Figure 7 is a flow diagram of an exemplary method for forwarding commands from a local media gateway to a remote media gateway through existing TDM links in accordance with the invention. In step **702**, the local media gateway **204** receives a command from the media gateway controller through, for example, the Ethernet port of the local media gateway **204**. In step **704**, the local media gateway **204** determines whether the command is addressed to the local media gateway **204** or the remote media gateway **210**. If the command is addressed to the local media gateway **204**, then the local media gateway **204** processes the command in the normal manner (step **706**). This may include, for example, executing steps in the control module of the local media gateway **204**.

If the local media gateway **204** determines that the command is addressed to the remote media gateway **210**, then the local media gateway **204** encapsulates the command in a management command packet, as shown in step **708**. In step **710**, the local media gateway **204** encapsulates the management command packet in the information field of an HDLC frame. The

HDLC frame is then transmitted to the remote media gateway **210** via the TDM network **208** (step **712**).

It should be appreciated that the local media gateway **204** may support more than one remote media gateway **210**. In this case, the local media gateway **204** may determine, in step **704**, which of several remote media gateways **210** the command is intended based, for example, on the destination address of the command received from the media gateway controller. Since different TDM links may be used to support each of the remote media gateways, the local media gateway **204** may select the appropriate TDM link to use to transmit the encapsulated command in step **712**.

The remote media gateway **210** performs complementary steps to remove the command from the HDLC frame. Figure 8 is a flow diagram of exemplary steps performed by the remote media gateway **210** to recover the media gateway control command in accordance with the invention. In step **802**, the remote media gateway **210** receives the HDLC frame. The remote media gateway **210** removes the management command packet from the information field of the HDLC frame (step **804**). In step **806**, the remote media gateway **210** examines the management command packet header to determine the command type. The remote media gateway **210** performs the steps necessary to process the command based on the command type (step **808**). Examples of these steps are noted above with reference to Figure 6.

It should be appreciated that the remote media gateway **210** may support other network elements. For example, an emergency standalone

(ESA) processor may be connected to the remote media gateway **210** through, for example, the remote media gateway's Ethernet port. As is known in the art, the ESA provides local call processing and 911 access in the event of a loss of connectivity between the remote media gateway **210** and the media gateway controller. Under normal operations, the ESA processor operates in a dormant mode. In the dormant mode, the ESA sends and receives keep-alive messages to the media gateway controller and receives periodic database synchronization updates from the media gateway controller. If the ESA processor determines that both the ESA processor and the media gateway 210 can no longer communicate with the media gateway controller, then the ESA processor becomes active to provide basic line-to-line and line-to-trunk call processing over in-band trunks. Thus, the remote media gateway controller **210** may be used to encapsulate and transport messages between the media gateway controller and the ESA.

The remote media gateway **210** may undertake similar steps to those shown in Figure 7 in order to send a response back to the media gateway controller **202** through the local media gateway **204**. Accordingly, the remote media gateway **210** may execute steps similar to steps **708** through **712**. For example, the remote media gateway **210** may encapsulate a response in a management command packet. The management command packet may then be encapsulated in the information field of an HDLC frame. The HDLC frame may be transmitted from the remote media gateway **210** to the local media gateway **204**. Similarly, the local media gateway **204** may execute steps similar

to those shown in Figure 8 to recover the response sent by the remote media gateway **210** and forward the response to the media gateway controller **202**. For example, the local media gateway **204** may receive an HDLC frame from the remote media gateway **210**. The local media gateway **204** may then remove a management command packet from the information field of the HDLC frame. The local media gateway **204** may then examine the management command packet header to determine that the command packet includes a response. The response would then be forwarded to the media gateway controller **202**.

It should be appreciated that term "TDM link" or "TDM links" is used to describe one or more time slots on one or more TDM trunks in a TDM network. Time slots may be dynamically assigned to provide sufficient bandwidth to perform management and control functions. For example, additional time slots may be assigned during bandwidth intensive operations, such as a database download or control software upgrade, and then made available for call processing once the operation is complete. Moreover, separate TDM links may be provisioned such that control commands are sent over one TDM link and management commands are sent over another TDM link. One advantage to the separate provisioning of the management link and control link is that bandwidth could be independently allocated to each message type. Thus, the bandwidth allocated to the control link could be set based on the call capacity of the remote media gateway, while the bandwidth for the management link could be dynamically allocated. During peak call times, the bandwidth for the

management link could be reduced independently of the control link bandwidth to permit greater call capacity while not decreasing call control throughput. Another advantage of separate provisioning is that the management link and the control link may be initially assigned to predetermined time slots, which may be desirable during the initial configuration of a media gateway, especially one at a remote location.

Accordingly, a system and method for providing remote management of a media gateway using a standard media gateway control protocol transmitted across a TDM link has been described. The system and method includes placing media gateway control commands within the information field of an HDLC frame and transmitting the HDLC frame across a TDM network from a local media gateway to a remote media gateway. The remote media gateway removes the media gateway control command from the HDLC frame and processes the command. Likewise, a response generated by a remote media gateway may be forwarded through the TDM network through a local media gateway and received by the media gateway controller. Thus, by encapsulating media gateway control commands in HDLC frames, media gateways can be remotely controlled over existing TDM links and without constructing a new data network.

It will be understood that various details of the invention may be changed without departing from the scope of the invention. Furthermore, the foregoing description is for the purpose of illustration only, and not for the purpose of limitation, as the invention is defined by the claims as set forth hereinafter.